Seismological Observations and Modelling at Erebus volcano, Antarctica

MOUNT EREBUS VOLCANO OBSERVATORY

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INTRODUCTION

Erebus volcano (Ross Island, Antarctica) is one of Earth's most continuously active volcanoes, with a persistent convecting lake of anorthoclase phonolite magma. Over the last 35 years the volcano has produced frequent Strombolian eruptions, resulting from large (up to tens of m-diameter) gas slugs bursting at the surface of the lava lake. Smaller ash eruptions are rarely observed from adjacent more constricted vents.

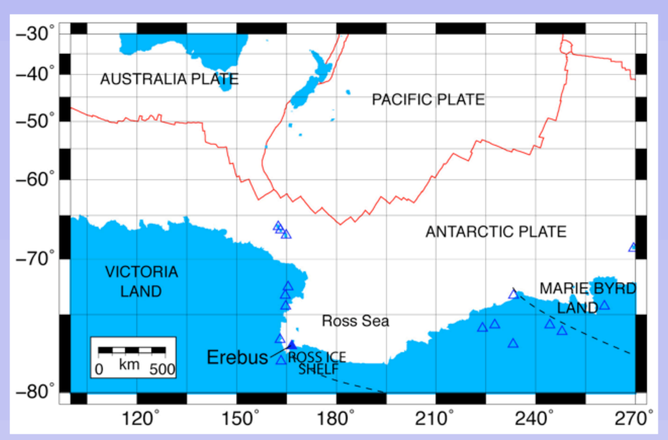


Fig.1: Regional map of the Ross Sea region, showing active plate boundaries (red lines, *Bird, 2003*), volcanoes (blue triangles, *Global Volcanism Program* database) and inferred boundary of the West Antarctic Rift System (dashed black line, (*Rocchi et al., 2002*). The location of Erebus volcano is indicated.

The activity of the magmatic system and of the lava lake has been studied since the early 1970s using a variety of instruments, including both portable and long-running seismic and infrasonic networks and video observations (*Aster et al., 2004*).

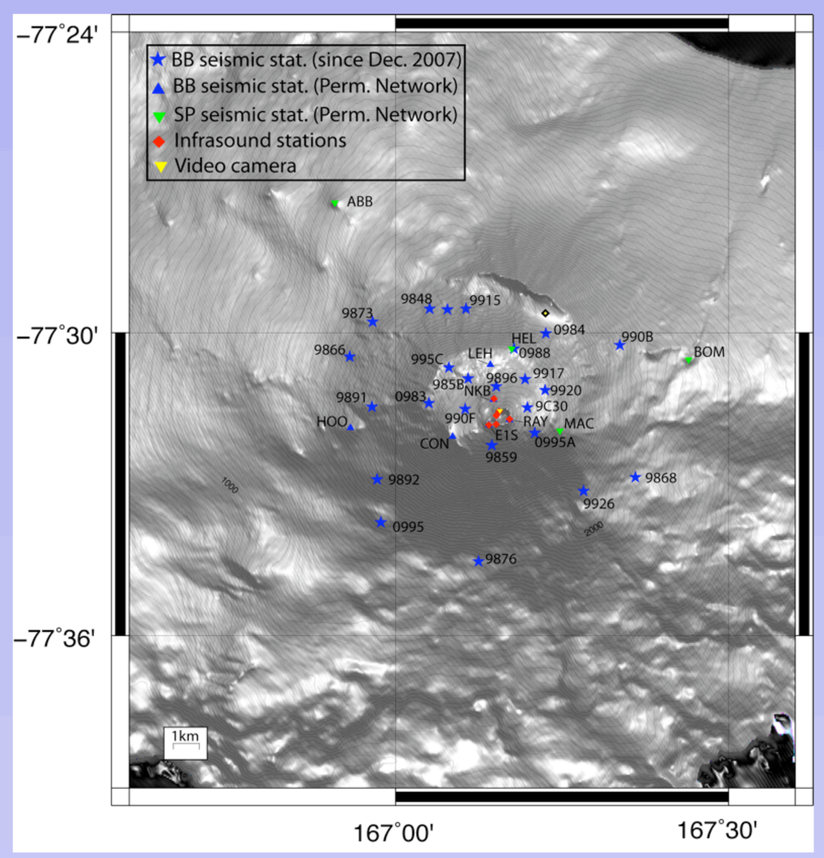


Fig. 2: Detailed map of Erebus volcano summit, showing up-to-date deployment of seismic and infrasound stations and video camera (*see legend for details*). Topographic map with 50 m interval isohypses.

ONGOING PROJECTS

Ongoing research at the Mount Erebus Volcano Observatory includes a wide spectrum of projects aimed to understand the eruption physics and to model the reservoir and the plumbing system of the volcano. They include: Very Long Period (VLP) moment tensor inversion of mass transport and pressurization recharge processes in the pre- and post-eruptive conduit system; analysis of temporally varying lags between VLP and short period explosion signals and implications for gas slug propagation and VLP excitation; analysis of the scattered and ambient wave field and infrasonic quantification of eruption source parameters.

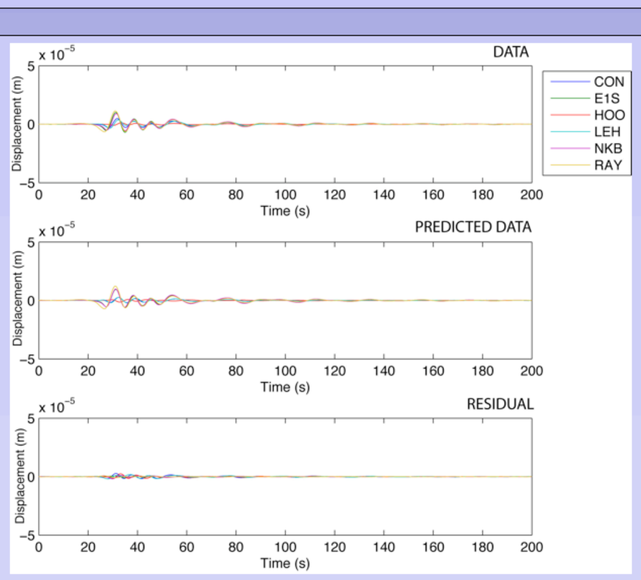


Fig. 3: Representative Very Long Period signals (vertical component) from strombolian explosions (Aster et al., 2003). By inversion of the Moment Tensor and force functions of the source mechanism, the best location for the source centroid is determined. In figure Data, Forward Modeling and Residuals corresponding to the best least-squares solution are represented (*Zandomeneghi et al., in preparation*). Early results favour an azimuthally symmetric source consistent with a pressurized and advecting subvertical conduit responding to disequilibrium induced by mass removal in Strombolian eruptions.

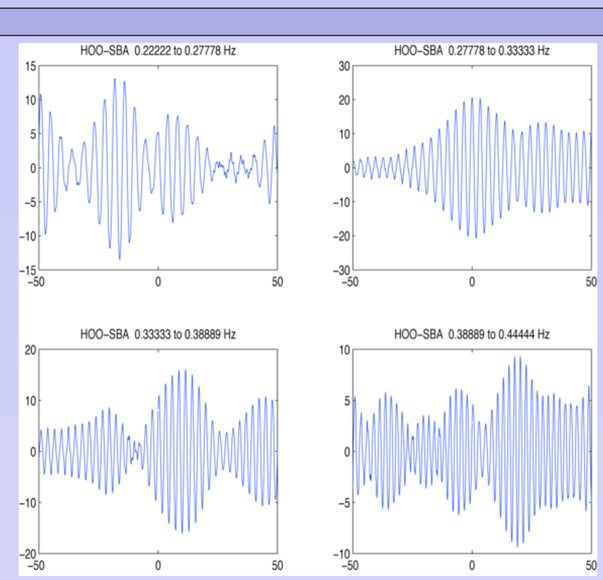


Fig. 4: Example of Rayleigh waves in different frequency bands recovered between stations SBA (Scott Base, not shown in Fig.2) and HOO, via cross-correlation of ambient noise. The arrival of the group velocities of these waves will be inverted to complement velocity modelling (Brenguier et al., 2007; *Chaput et al., in preparation*).

Tomography experiment 2008-2009 Season

In November/ December 2007 an array of 23 temporary IRIS PASSCAL broadband seismometers was deployed for 15 months around the flanks and summit of the volcano to provide passive and controlled-source tomography.

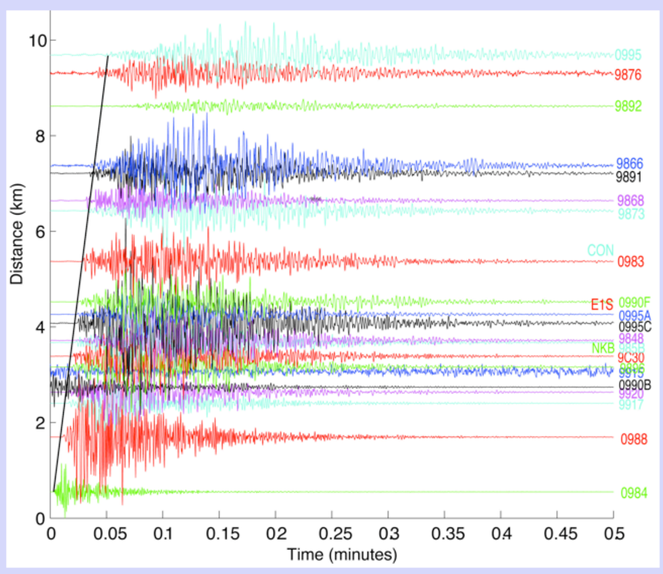
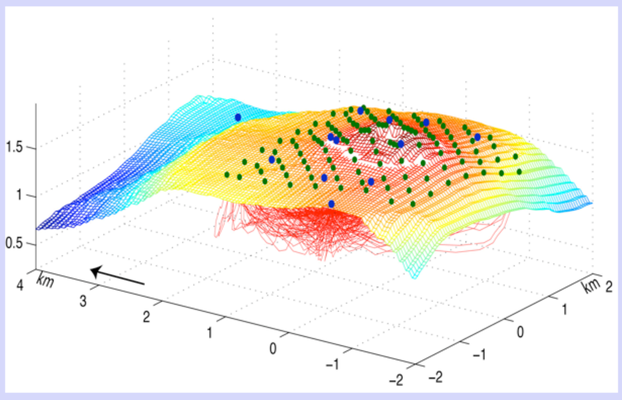


Fig. 5: Seismic records (vertical component), of the shot signal of January 19, 2008, (01:40 pm). The approximate first arrival moveout is marked with a black line (3.2 km/s). See map in Fig. 2 for station names and locations. White diamond in Fig 2 indicates the shot position (*Chaput et al., 2008*).

During the 2008/09 Austral summer field season this array will be supplemented with 120-150 seismometers (3 components 4.5 Hz geophones) installed on the summit and flanks of the volcano, in a more extensive controlled-source seismic experiment. Twenty chemical shots using between 100 and 250 kg (of ANFO) will be set in 12 m deep holes drilled in the snow/ice cover. This on-going work will provide the first detailed image of the magmatic system of Erebus volcano. The data will be analysed to produce a regional 2D refraction profile of the upper 5 km of the volcanic system. Moreover, a challenging 3D velocity tomography will image the plumbing system in the upper portion of the volcano (~1 km depth) with very high-resolution (*Toomey et al., 1994*).



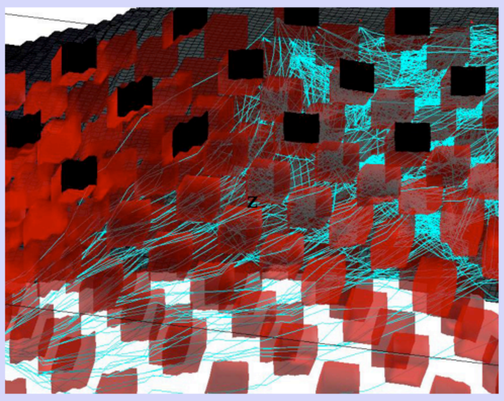


Fig. 6: Example of synthetic tests performed in the experiment planning. Distribution of (a) stations (green circles) and shots (blue circles) in the modelled volume. Coloured Grid: modelled topography. Red lines: seismic ray paths (b) detail of ray distribution in the Checkerboard Test. Red Cuboids: synthetic anomalies (DVp -10%), 0.4 x 0.4 x 0.4 km. Cyan lines: seismic ray path.

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